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OF FINE GOLD

IN THE

SANDS OF SNAKE RIVER, IDAHO.

BY

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THE TREATMENT OF FINE GOLD IN THE SANDS OF SNAKE RIVER, IDAHO.

BY T. EGLESTON, PH.D., NEW YORK CITY.

(Ottawa Meeting, October, 1889.)

THE sands of Snake River, Idaho, have long been known to contain gold. They were worked by some of the first prospectors who came to Idaho, and on the banks still stand the ruins of camps abandoned for years. There are almost always prospectors searching for gold during the season of low water, and it is not an infrequent thing to find a miner of the old type actually panning the sand, or the prospect-hole which he has just left. There is more or less mystery about these miners and their methods of finding the spots where they work. They are always subjects of much speculation to the ordinary traveller. The rich discoveries are, for the best of reasons, concealed until the claims can be taken up. It is difficult to find a place where there are no prospects, but the "colors" are so very fine that they do not offer much inducement to enterprise. The California miner usually values a color at from 5 to 10 cents, often the latter; while on Snake River it would take 100 colors, or even more, to make that amount.

There is not much difficulty in panning out the heavier pieces of this gravel, so that those which remain have not over half the diameter of a pin's head. Below this size the separation is extremely difficult, as the flakes are very thin. The heavier pieces of the basalt, the black sand and fine gold remain persistently together; and, after the iron has been separated by a magnet, there still remains a material which appears grayish to the eye, has about the same gravity as the light particles of gold, and cannot be removed with an electro-magnet run by a very strong battery. After the heavy black sand has been separated by the magnet, the fine particles of gold float, while the gray sand sinks; so that I had the greatest difficulty in concentrating half a liter of material, taken up from under the head of the burlap sluice, into a bulk of 15 by 4 millimeters. A large part of the concentrated gold floats; and when, after much trouble, the surfaces are wetted and the gold is got under the water on to the top of

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the sand, the first wave from the other side of the pan over the sand floats the gold again.

The minerals contained in the fine sand are quartz, chalcedony, semi-opal, zircon, topaz and magnetite. I have not been able to distinguish any trace of pyrite, and have only occasionally seen small grains of periodote. These minerals are sometimes ground and broken, and sometimes are small detached crystals, which can, however, be seen only with high powers. The gold itself is in flattened forms. Almost every piece is convex and shows surfaces which are bright and more or less mammilated, having the appearance of having been acted upon by some reagent. They are quite similar to the artificial nuggets which I described some years since.*

It is a question of interest how this gold got into the sands. The most probable answer seems, at first sight, to be that it came from the abrasion of the rocks. This leads to the further question, Why is it, then, so very much finer than gold-sands ordinarily are? I do not pretend to be able to answer these questions decisively now, but hope to do so at some future time. The object of this paper is rather to describe the method in use for catching a part of the gold.

Snake River, during the course of nearly 100 miles, which I have studied, runs through a columnar basalt. This rock covers the plains, where the surface of the flow is covered with great nodules from 15 to 40 feet in diameter, and from 10 to 20 feet high, which have a radiated and at the same time a columnar structure. The erosion and destruction of this rock has formed the sands of the great Idaho desert. The rock is much fissured and is covered only to a slight depth with sand. It is generally compact, but the surface of the ground is covered in some places with small pieces so full of bubble holes that they appear like scoria. All such pieces have a more or less large coating of silica on them. It is in this rock that the Lost River disappears, to come out again, as is generally believed, in one of the numerous large springs which flow from the north side of the bluff below Shoshone Falls.

The Oregon Short Line railroad crosses Snake River at American Falls station, where the river is 1500 feet wide and descends 50 feet in several falls 10 or 15 feet high between bluffs 30 to 60 feet high. It runs West in this way a little over 100 miles, the bluffs on both sides of the river gradually growing deeper, until at what is known as Twin Falls the river suddenly falls 175 feet, leaving the bluffs

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* *Trans.*, ix, p. 633.

500 feet high. In the course of the next 3 miles it forms Shoshone Falls, where the river first narrows to 750 feet in width and then takes a jump, first of 75 feet and then, within a few yards, of 210 feet, leaving the bluffs at the foot of the Falls 1200 feet high on both sides of the cañon and the river 1000 feet wide. The top of the bluffs is a very hard compact basalt, with occasional small nodules of chalcedony, but only in a single place, just above the Twin Lakes, below Shoshone Falls, did I see in this top rock any large holes, and nowhere any appearance of weathering or decomposition in the rock itself in place. The rock is in many places coated with a white covering of silica, formed by the evaporation of the water percolating through or collected on the surface. These coatings sometimes take fantastic shapes, as in the case of the Devil's Spade, about a mile above Shoshone Falls, where what appears to be a painting in white of a gardener's spade can be seen in a niche just below the top of the bluff. Notwithstanding this deposition of silica, the rock shows to the eye no trace of decomposition. I was told that iron pyrites is found in nodules in the upper part of the bluffs; but I did not see, in the course of more than a week that I spent on the river, a single piece of iron pyrites, however small, though I looked carefully for it. Below the great Shoshone Falls, on the level of the river, the rock is porphyritic, light gray in color, and much more felspathic and friable than the basalt above, and thoroughly rotten from decomposition. About 100 feet from the foot of the falls it is so worn away that I crawled through apertures in the decomposed rock for 25 or 30 feet, at a distance of about 10 feet above the water, the outside of the rock still being intact. This decomposition is much like that which occurs in the sand-rock of the Kentucky River near Jackson, Ky. It is not an uncommon thing in the various side-cañons which lead into the main cañon of the river to find that the bottom-rock has been so much decomposed, by the absorption of its alkalies, or so much washed out, that pieces of the overhanging hard rock, 50 to 75 feet in length and 8 to 10 feet in width, have dropped down, retaining their vertical position, leaving a chasm 2 or 3 feet wide between them and the main rock. Striking examples of this occur in the side cañon near the Twin Falls and below the Great Falls.

This decomposition of the underlying rock has taken place on a very large scale, and is particularly visible just above and for a considerable distance below the main falls, so that the surface for 500 feet from the main cliff is broken up into what appears at first sight

to be small terraces, which are difficult of access. From the top of the cliffs this sinking of the rocks gives an appearance, on a very small scale, quite similar to the grand cañon of the Colorado river, as seen about 75 miles from Flagstaff, Arizona, when the same phenomena takes place on a different rock, on a scale probably larger than anywhere else in the world. The water of the river is cool, and slightly alkaline to the taste. The soil is full of alkali, which is undoubtedly one of the results of the decomposition of the rock. It is also probably one of the sources of the solution of the gold, and its subsequent deposition in the sands of the high banks as well as the deposition of the silica minerals formed by evaporation.

It is a fact well known to those who chlorinate pyrites concentrates, that the gold they contain is in all degrees of fineness; that, in some cases, it is extremely difficult to attack the gold; and that, in other cases, the loss in roasting is enormous, on account of the very large surface, as compared to the weight, of the gold particles. It is known that the gold is much finer in some pyrites than in others, and I supposed at first that this might account perfectly for the condition of the gold in these sands. The microscopic examination, however, does not justify the conclusion that the gold has come exclusively from the decomposition of pyrites; since in no case have I been able to find any gold that was coated, or the surface of which was not just as bright as if it had been for a long time exposed to chemicals. That small quantities of gold are contained in solution in the waters flowing through these rocks seems to be probable. The experiments that I have been able to make in the laboratory tend to confirm this opinion.

Snake River, below Shoshone Falls, runs for 18 miles through basalt, the height of the bluff varying from 1200 feet at the falls to about 500 feet at the end of that distance. It then commences to widen out gradually, the talus of sand increasing little by little in height until at last the outlines of the rock only, come up at the top of the bluff. These finally disappear; and what was a talus becomes sand-hills on the south side, and, on the north, more or less irregular sand-bottoms, with cliffs of basalt varying in height, but generally not more than 30 to 40 feet high, so that in several places roads have been constructed in the side cañons from both sides down on to the bottoms. On the top of the bluff there is no water. The rock is columnar and very much fissured. It dips South, so that there are no springs on the South side of the river, but all along the North side at intervals of three or four miles great springs

gush out, which form at once considerable streams, issuing directly from the rock.

The river bottom-lands widen from nothing to about half a mile. They rise above low-water mark as much as 30 to 40 feet. Where it is possible to get water to them, either from the springs on the North side or by flumes taking water high up the river on either side, the sands, after the alkali is washed out of them, make excellent soil, and in both ways some beautiful ranches have been made.

The sand in the river contains some gold, not in large quantity anywhere. It is so very fine that it is difficult to collect it without special apparatus. The gold value of these sands is estimated at about five cents to the cubic yard, which includes top soil and bottom gravel as well. The pay-streak is richer than this, but in the working it is impossible to make any separation.

The pay-streaks, after prospecting, are worked on both sides of the river. There are a number of these placer-workings about 50 miles below Shoshone Falls, which have been operated for a number of years by a method but little known. One of these, known as Hunt's placer-claim, at Salmon Falls, which is 17 miles across the desert from Bliss station on the Oregon Short Line railroad, I had occasion to visit in the summer of 1889.

The method of excavating the sands is simple. It consists in bringing a ditch into the pay-dirt, and making the ditch itself do almost all the work of excavation. The fall of the water breaks the ground down, and sufficient grade is given to carry it to the machines. The best grade for the water-ditch has been found to be 4 inches in 12 feet. Ditches with earthen banks, and flumes, sometimes partly in earth, and at others wholly on tressels, are used. When the ground-sluice is not over 36 inches wide, gravel runs easily on a 4-inch grade. The long flumes have a grade of $3\frac{1}{2}$ inches in 12 feet. The ground-sluice is made so as to work gradually back, cutting itself out by the fall of the water. The top soil is broken back by the pit-man with a steel bar, and the lumps are broken up with a light pick. The pay-gravel varies from 10 to 25 feet in thickness, and has to be washed in benches, taking from 5 to 8 feet for a bench. No ditch is required in the gravelly places. The stream is directed around the bank by the pit-man, who uses "shear boards", 14 inches wide and 2 inches thick, with round sticks 1 foot long and 2 inches in diameter, run through them as handles. These are so placed as to direct the water against the bank, to undermine it slowly, so that the sands cave, but not so rapidly as to impede the course of the water. These planks require the

constant attention, in the day time, of one man in the pit, who in ten hours will bar down ground enough to keep the machine working for twenty-four hours. The skill of the pit-man consists in so barring his gravel and arranging his shear-boards that the pit will take care of itself at night. The current must be strong enough to carry all that falls into the sluice leading to the machine. Occasionally, the ground-sluice is dammed by the gravel in the night, and cuts a channel in such a way as to make it impossible to reach certain blocks of ground. This is not, however, a serious inconvenience; since the ground has to be broken in benches, and the spot so left is taken in, in working the bench below.

The stream carrying the broken-up gravel runs through sluices, in general not more than 24 inches wide. But, from about 8 feet before it reaches the first iron plate of the machine, the sluice is enlarged, so that where it meets the plate, it is 4 feet wide. The machine consists of a board-sluice Figs 1 and 2, lined with perforated sheet-iron plates, 3 by 4 feet in size, which are called "grizzlies." Below them, on both sides, is an inclined sluice, leading to an undercurrent, which discharges into sluices covered with burlap, called "sack-boxes." The width of the machine is constant; but the length varies with the fineness of the gold to be caught. At Hunt's claim there are three—one 24, one 30, and one 36 feet long. The flume that carries the gravel is 1 foot lower than the top of the "grizzly." The sand accumulates here and makes a pavement, and prevents the wearing of the bottom. In some of the small machines this sluice is paved for some distance with wooden blocks placed on end; but all of them have blank plates for the length of one plate, at least, set almost without grade; and these have been found to wear best, as the water builds its own grade from the sluice to the machine. The blank plate is 4 feet long. It is made, like the other plates, of steel or coke iron, $\frac{5}{32}$ of an inch thick. The grizzly-plates are perforated with conical holes, $\frac{1}{2}$ an inch between centers, which are $\frac{5}{32}$ on the top and $\frac{3}{8}$ on the bottom, to prevent the holes from clogging. These plates are 3 feet long and 4 feet wide. The sides of the sluice are made of boards, 1 inch thick and 12 inches wide, except just over the undercurrent, where they are 2 feet wide. The grade of the "grizzlies" varies from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch, according to the size of the gravel. The coarser it is, the more grade is required. In setting up the machine, a frame is first built, and on this the grizzly is placed loose, so that the grade can be changed if necessary by wedges placed underneath it. Ordinarily, $\frac{1}{2}$ an inch to the foot is

found to be the best grade. When the grade is determined, the grizzly is wedged firmly to its place. At the end the grizzly discharges the

FIG. 1.—Plan.

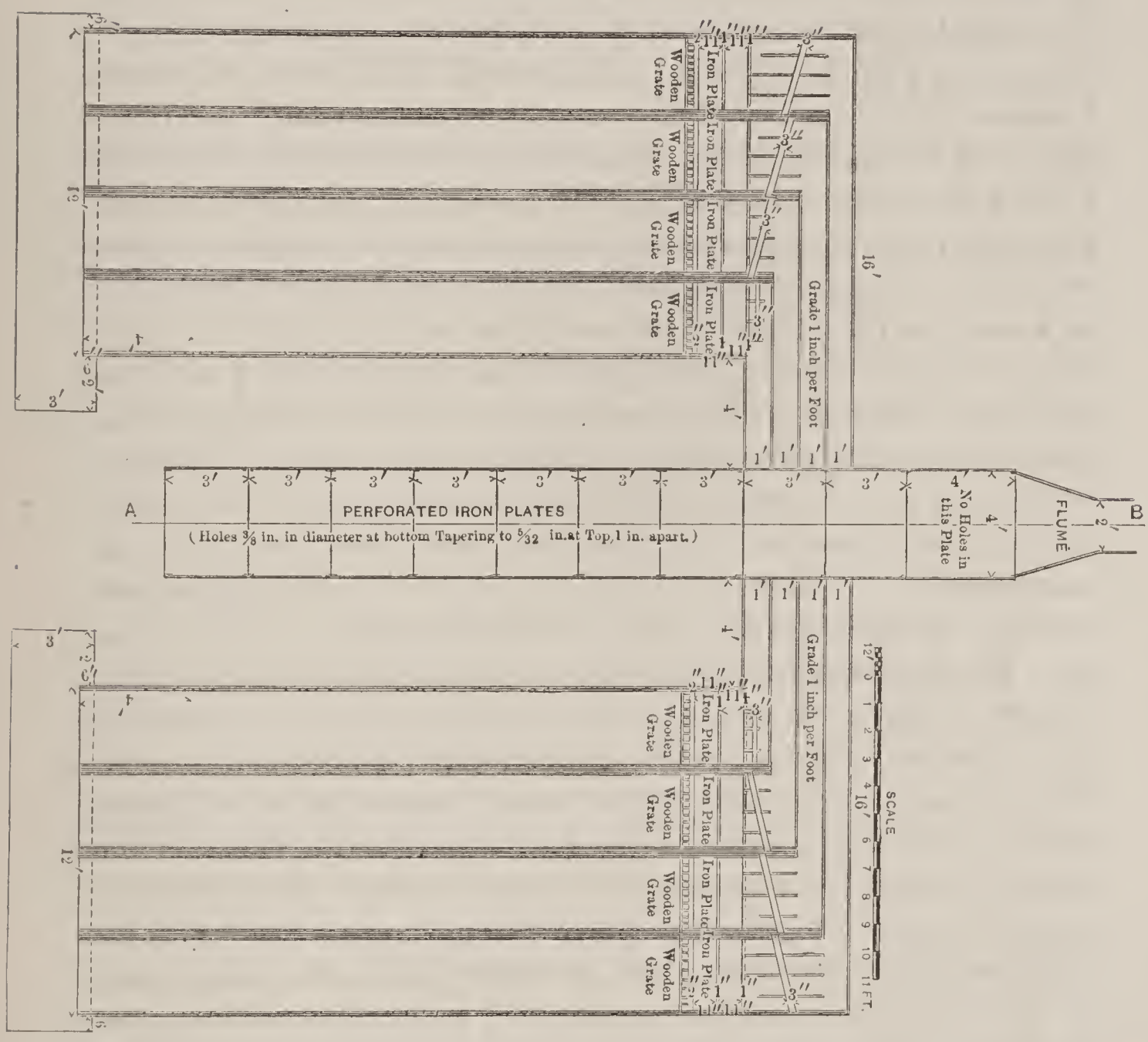
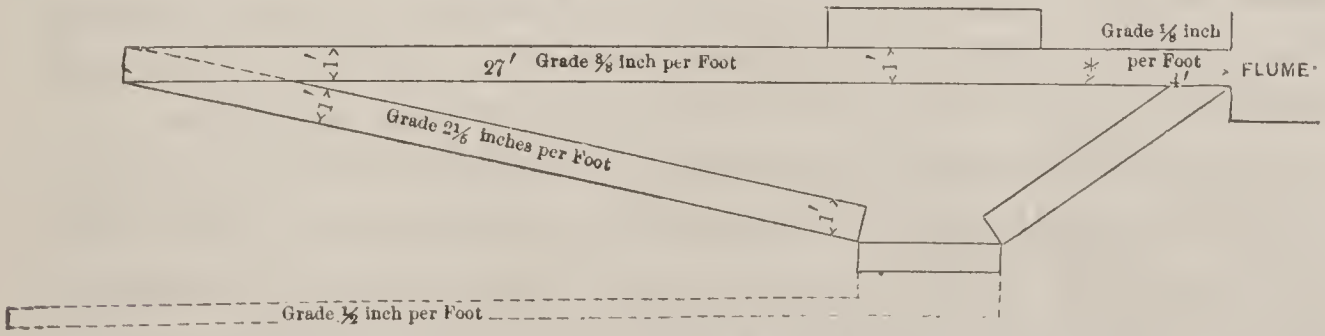


FIG. 2.
Section through A B, FIG. 1.



Plan and Section of Apparatus for Saving Fine Gold.

material too large to go through the holes into the tail sluice, which must have sufficient grade to carry off all the tails. Below the

grizzly the sides incline both ways towards the center at the rate of 2 to 3 inches, or more, to the foot, and end in an undercurrent called a "sand-tank," which is 4 feet wide. This has a grade of $1\frac{1}{2}$ inches to the foot, towards each side. It is generally placed immediately under the center line in the middle of the machine, but its exact position depends on the lay of the ground. In its center is a sump, 4 inches lower than the lead-boxes, so as to distribute the water equally to the burlap-sluices on each side of the machine. These are 4 feet wide, incline $\frac{1}{2}$ to $\frac{3}{8}$ of an inch to the foot, and are arranged according to the length of the grizzly. For the 36-foot grizzly there are twelve of them, six on a side; for the 30-foot, there are ten, five on a side; for the 24-foot, there usually are only six, three on a side. Four would work better. The grade of the lead-boxes is $\frac{1}{2}$ to 1 inch to the foot. The lead-sluices are arranged, so that the back one carries the gravel to the sluice furthest away from the machine. They are 10 inches wide. In order to distribute the sand evenly in the width of the sluice, there are four divisions at their head, which vary in length so as to distribute the current equally. At their upper end there is a movable grating made of strips of wood, set inclined, to keep out any floating matter which may accidentally get in, and to further distribute the stream. The sluice-boxes are 3 feet wide, and 24, 30 and 36 feet long; made of thin boards placed end to end. The sides are 6 inches high and are nailed to the sides of the bottom boards. They have a grade of $\frac{1}{4}$ to $\frac{3}{4}$ of an inch to the foot. If the material treated is all sand, which is the usual case, the grade is $\frac{1}{4}$; if gravel and sand together, $\frac{3}{4}$. These burlap-sluices connect with the tail-sluice by a sluice at their end, at right angles to the main sluice, which is 3 feet wide and has a grade of $\frac{1}{2}$ an inch to the foot, over which the burlap-sluices project 6 inches, and which projects 2 feet beyond them. These sluices, like the grizzly, are set on a frame, so that the grade can be changed by wedging, and when once determined on, can be set firmly in place. As the tail-sluices are on both sides of the machine, they discharge in front of the grizzly with sufficient force to move all the tails down the main tail-sluice.

At the head of the burlap-sluice, just beyond the wooden gratings, which regulate the flow of the gravel, is a cross-cleat, under which an iron plate, 1 foot wide and as long as the width of the sluice is fitted. This is made of old grizzly iron. It is held down at the side by a cleat, under which it slips.

The sluice is covered with burlap 40 inches wide. It has been found by experience that 7 ounces to the yard is the best burlap to use. Heavier and lighter have been used, but are not found to

answer so well. The lead-sluices have a grade of 1 inch to the foot; when the plate is put on them, there is a slight drop; and here there is always gold to be seen at the clean-up. Each of the lead-sluices is so arranged that it can be cut off separately. This is done by a gate of wood wrapped with burlap to make it quite tight and, in order to further keep out the water, the burlap, which is to go on to the sluice after the clean-up, is thrust into the lead behind the gate, which prevents the passage of water and at the same time wets the burlap, so as to fit it to be spread out on the sluice. These gate-wrappings, as soon as the clean-up is finished, are hung up on each side of the grizzly, so as to be ready for use at the next clean-up. The burlaps on the sluices are held down by cleats of wood, kept in place by wooden eccentrics, screwed to the side, so that when they are turned down, they hold the cleat in place. These cleats are $1\frac{1}{2}$ by 1 inch and are cut from a 1-inch board. After six years' use some of them are so worn that they have to be turned up on their angles to meet the eccentrics. In the 24-inch sluice there are six of these on each side.

To make a clean-up, the man in the pit comes down to the machine with the superintendent, and the water is turned off from each of the sluices, one at a time, commencing always with the outside sluice. The assistant has a piece of flat rubber set in a handle. He knocks down the eccentrics on both sides of the sluice to be cleaned up, with the handle, so as to loosen the cleats. These are then taken out, washed in the next sluice and placed crosswise over it, to be at hand when wanted. The superintendent takes out the iron plate at the top and carefully scrapes off the sands and gold, washing the plate in the next sluice. The assistant takes the burlap from the bottom, brings it up to the center of the sluice, and commences to push with his rubber the material collected underneath the burlap on the bottom from the lower end to the middle of the sluice. The superintendent carries the top of the burlap to the middle, folds it to 18 inches and the width of the sluice, then doubles it over towards the side of the sluice, presses it flat with his feet, and places it in one of the boxes. There are two of these boxes for each sluice. They are 18 inches long, 13 inches wide, and $7\frac{1}{2}$ inches deep, and are lined with tin. The woodwork of the boxes is only knocked together, but with constant use they last four years. When the tin commences to rust through, so that they leak, the boxes are used exclusively for the burlaps. The tight boxes are always used for the sand. While the superintendent is arranging the blankets, the

assistant goes to the top and pushes the sand down to the middle, to be put into the other box. When the sluice is clean, the fresh-wetted burlap is taken out of the lead-sluice, the upper end being held by the superintendent and the lower end by the assistant, and stretched with both hands over the sluice, leaving the upper end of the burlap to project over the upper end of the sluice. The burlap is shoved under the cross-cleat by the iron plate, which is cut off at the corners to prevent cutting the burlap; this goes under the cleat and is held fast, leaving about 2 inches of the burlap projecting over the top of the plate. The side-cleats are now taken from the adjoining sluice and put in, commencing at the top. On their hands and knees the two men go from the top to the bottom, pressing the cloth in place, spreading the burlap so that it comes up to the sides of the cleats and sometimes over the top, according as it stretches. They then turn down the eccentrics, put in the grating, and turn on the water. This work, in a single sluice, takes five minutes. The next sluice is treated in the same way, and so on until the clean-up is completed. They are careful to spread the burlap tight and smooth; for, if it is wrinkled or bulges, sand collects under it and less gold is caught. If they are properly put down, only two or three pans of sand will be thus collected which, at the head of the sluice, contains considerable visible gold. Most of the gold, however, is caught in the burlaps.

The burlaps are cut so as to cover the whole length of the sluice and lap over the lower end; but they wear, and after some use grow short, so that they are generally eighteen inches to two feet shorter than the sluice. The lead-sluices at the head of the burlap-sluice, which distribute the stream, are keyed in and are kept together by diagonal strips. The grating is put in loose, 6 or 8 inches from the slats.

Nothing but burlap has been found to answer for this work. Ducking was used at one time, but it did not catch the gold so well and rotted too fast. The burlaps are used until they go to pieces from rotting. They usually last two months. When worn out, they are used around the gate. When they can no longer be used, they are dried and burned, and the ashes are panned. In order to prevent the closing of the pores by vegetable matter, the burlaps must be spread out in the sun to dry thoroughly after each clean-up, to destroy the plant-life before they can be used again. They last longest in summer. In the winter they are apt to tear from freezing at the sides. The whole work of the three machines is done by

five men,—one man in each pit; the helper, who does other work; and the superintendent, who, with the pit-men, makes the clean-up and "rocks" the dirt.

Over the 24-foot machine, 200 to 250 inches of water are constantly run in 24 hours: on the 30-foot, 350; and on the 36-foot, 400 inches. The work done on each machine averages about a cubic yard of gravel for each miner's inch of water used. The essential requisite is to secure a good dump; unless this is done, the tail-sluices will soon be filled up. Usually, on Snake river the spring freshets wash the tail-sluices out; but for two or three years, on account of the low water in the river, this has not been the case. It is also necessary to set the bed-rock sluice in such a way that there will be plenty of water the year round. In some places it has been set too high, so that when the river is low there is no water to wash with, while there is plenty of water in the river. Not only plenty of water, but free water is essential to the economical success of this process.

The boxes from two of the machines which are at a distance, are cleaned in a shed near the house, half a mile from the sluices. In one which is difficult of access, the rocking is done on the spot. The clean-up house is 14 by 12 feet. On the long side against a window is the washing-tank. An ordinary gold-sand rocker is placed at the end next a window, and the retort-furnace opposite to it. The boxes containing the burlaps are piled next the washing-tank. The sand in the boxes is piled next to the rocker. The washing-tank is 10 feet long, 3 feet wide and 3 feet deep. It has a shelf 6 inches wide behind, and one 4 inches wide at an angle of forty-five degrees in front. The burlap taken from the box is washed several times up and down in the tank, where water is constantly running in and out. It is then allowed to fall into the tank; the end being held by the hand, is washed by shaking it on to the front ledge, and is then folded backward and forward so as to make the folds 1 foot wide. It is then thrown on to the ledge behind. The gold sand from the burlap which remains on the front ledge is then washed into the tank, the end of the burlap is brought over on to the front ledge, while the rest remains on the opposite ledge, and the space between the two parts of the burlap washed up and down and again folded on the front ledge. This is repeated twice; so that each burlap is washed three times. The ledge is washed every time to throw the gold into the water. The washing is done at some distance from the discharge-pipe, to avoid the danger of the fine gold floating off. The sand collected at the bottom of the

vat is allowed to settle until the water is almost clear. The water is drawn off from above at three plug-holes, at different levels, and the sand collected is rocked. The rocker has a plate 60 inches long by 24 inches wide. The end and sides are turned up 1 inch, so that the inside space on the plate is 22 by 59. The hopper, into which the sand is put, is 13 by 15 inches, and 5 inches deep. The bottom of the hopper is made of a grizzly plate and the constant washing has worn grooves laterally towards the holes. The inclination of the plate is $2\frac{3}{4}$ inches in 2 feet, which experience has shown to be the best. The plate is copper and not silvered, silver-plated plates not having been found to answer. The plate is first washed with a swab soaked in potassium cyanide. Then mercury, sprinkled half way down through a fine cloth placed over the end of a bottle, is wiped over the surface with the cyanide swab. The sand is put in at the hopper and the rocker is rocked seventy-eight times a minute. What comes off the plate runs into a tail-sluice, and carries almost no gold, not more than two dollars to the ton. About seven small coal-shovels full are worked in a minute, care being taken never to clog the holes. This is all that is done with the sand from the boxes. The sand from the tank is mixed with cyanide, the proportion being determined by trial, and allowed to stand two hours before rocking. The moment the rocker is stopped, the end of the amalgamated plate is turned up so as to drain to the back, to prevent the loss of mercury and amalgam. Each machine is cleaned twice a week. The 24-foot treats from 78 to 80 tons per day, and the others correspondingly more. The gold collected by this method is very fine,—much finer than any that I have seen, except from some of the Arizona placers.

The machine runs itself, with only one man in the pit. It pays to run sand which has from 50 to 85 colors. These machines collect from thirty-five to forty dollars a day each. The work of the clean-up varies with the size of the machine. With the 30-foot machine, all the work of cleaning up the sluices, washing the burlaps, spreading them out to dry, and rocking, is done in six hours. The 36-foot machine takes an hour longer, and the 24-foot an hour less.

This method is one of the least expensive of all the devices for the treatment of fine gold. It requires but little capital and labor, and the returns well repay the men. It requires, however, free water. By changing the grade of the machine and sluices,

and multiplying the number of burlaps, very close work can be done.

I desire to express my obligations to Mr. J. S. Hunt, the owner of this claim, and Mr. C. M. Peters, the superintendent, for the assistance they gave me while studying the method on the spot, and since my return to the East.